भारतीय मानक
Indian Standard

IS 14983 : 2022

फॉस्फोरस (पीले या सफेद) — सुरक्षा संहिता

(पहला पुनरीक्षण)

Phosphorus (White or Yellow) — Code of Safety

(First Revision)

ICS 13.300; 71.060.10

© BIS 2022

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली – 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
www.bis.gov.in www.standardsbis.in

July 2022 **Price Group 5**

Chemical Hazards Sectional Committee, CHD 07

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards on recommendation of the Chemical Hazards Sectional Committee and approval of the Chemical Division Council.

White phosphorus is used in the manufacture of pesticide intermediates, rodenticides, semiconductors, incendiaries, fireworks, electroluminescent coatings, pyrotechnics, electronics industry, detergents, metal treatment, animal feed, phosphoric acid, phosphor bronze, metallic phosphides and other phosphorus compounds. It is also used for production of mortars, hand grenades, etc.

White or yellow phosphorus does not react with water and is stable as long as it is kept wet or otherwise excluded from air. Contact of the product with oxidizing materials (including elemental sulphur) may cause a vigorous reaction or explosion. Contact with strong caustic may result in evolution of poisonous and flammable phosphine gas, and the product is otherwise reactive with a wide variety of substances. Smoke of the burning product is irritating and toxic by inhalation. The product is highly hazardous if physically contacted or ingested.

The elimination of accidents is vital to public interest. Accidents produce social and economic loss, and impair individual or group productivity. Realization of this loss has led the authorities to devote a good deal of attention to safety education. Apart from general precautions, some typical precautions are required to be taken during manufacture, storage and handling of white or yellow phosphorous. This code of safety lays special emphasis on these points.

This standard was originally published in 2002. The Committee felt a need to revise this standard with a view to update the standard based on the experience of last three decades and on the currently available data. In this revision general properties have been incorporated and modifications have been made to update safety measures for controlling hazards and essential information on symptoms of poisoning, first-aid, medical treatment, storage, handling, labelling and employee safety.

In the preparation of this code of safety considerable assistance was derived from the following publications:

a) Chemical safety data sheets – SD-16, Manufacturing Chemists Association, 1825 Connecticut Avenue, Washington, D.C. 20009.
b) Sax's Dangerous Properties of Industrial Materials, Volume Three, Tenth Edition, Richard J. Lewis Sr., Wiley-Interscience Publication, 2000.
c) NIOSH, Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services Centres for Disease Control, 1990 (National Institute for Occupational Safety and Health).
d) IPCS-International Program on Chemical Safety, 2004 edition.
e) AERB SAFETY GUIDELINES NO. AERB/SG.

The composition of the committee responsible for the formulation of this standard is given at Annex A.

Indian Standard

PHOSPHORUS (WHITE OR YELLOW) — CODE OF SAFETY

(First Revision)

1 SCOPE

This code describes the properties of white or yellow phosphorus and nature of hazards associated with it. The standard prescribes safety measures for controlling hazards and essential information on symptoms of poisoning, first-aid, medical treatment, storage, handling, labelling and employee safety.

This code does not, however, deal with specifications for design of buildings, chemical engineering plants, method and ingredients used in the manufacture, equipment for waste disposal and operation control.

2 REFERENCES

The Indian Standards listed below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revisions, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards:

IS No.	*Title*
4155 : 1966	Glossary of terms relating to chemical and radiation hazards and hazardous chemicals
8519 : 1977	Guide for selection of industrial safety equipment for body protection
8520 : 1977	Guide for selection of industrial safety equipment for eye, face and ear protection
8807 : 1978	Guide for selection of industrial safety equipment for protection of arms and hands
10667 : 1983	Guide for selection of industrial safety equipment for protection of foot and leg

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 4155 shall apply.

4 PROPERTIES

4.1 General Information

White or yellow phosphorus spontaneously catches fire in air, it does not react with water and is stable as long as it is kept wet or otherwise excluded from air. Contact of the product with oxidizing materials may cause a vigorous reaction or explosion. Contact with strong caustic may result in evolution of poisonous and flammable phosphine gas, and the product is otherwise reactive with a wide variety of substances. The smoke of the burning product is irritating and toxic by inhalation. The product is highly hazardous if physically contacted or ingested.

4.1.1 *Chemical Name* — Phosphorus.

4.1.2 *Common Name and Synonyms* — Phosphorus, white phosphorus, yellow phosphorus.

4.1.3 *Uses*

White phosphorus is having extensive uses in the manufacture of pesticide intermediates, rodenticides, fire retardants, semiconductors, solar cells, electroluminescent coatings, fireworks, pyrotechnics, electronics industry, detergents, metal treatment, animal feed, phosphoric acid, phosphor bronze, metallic phosphides and other phosphorus compounds.

It is also used for production of mortars, hand grenades, incendiaries, etc.

4.2 Identification

4.2.1 *Formula* — P_4.

4.2.2 *CAS Number* — 12185-10-3 (Also reported 7723-14-0).

4.2.3 *UN Number* — 1381/2447.

4.2.4 *UN Class* — 4.2, Subsidiary Risk 6.1.

4.2.5 *Hazchem Code* — 1WE.

4.3 Physical Properties

4.3.1 *General*

Colourless to yellow crystalline solid with waxy appearance. Turns dark on exposure to light.

4.3.2 *Molecular Mass* — 123.88.

4.3.3 *Physical State* — Waxy solid and cubic crystals.

4.3.4 *Colour* — Colourless to pale yellow.

4.3.5 *Odour* — Pungent, sharp, garlic like (smell of oxide of phosphorus).

4.3.6 *Boiling Point* — 279.7°C.

4.3.7 *Melting Point* — 44.1°C.

4.3.8 *Vapour Density (Air = 1)* — 4.42.

4.3.9 *Specific Gravity*

a) Solid (water = 1) at 20°C — 1.82.
b) Liquid (water = 1) — 1.745.

4.3.10 *Viscosity* at 30°C — 2.037 cP.

4.3.11 *Vapour Pressure* at 76.6°C — 1 mm Hg.

4.3.12 *Heat of Combustion* — (–) 5 900 kcal/kg.

4.3.13 *Refractive Index* at 25°C — 2.144 2.

4.3.14 *Solubility in Water* — Almost insoluble in water (0.000 3 g/100 g water at 20°C).

4.3.15 *Solubility in Other Solvents* — Soluble in alkali, ammonia, benzene, carbon disulphide, chloroform, ether and toluene.

4.3.16 *Light Sensitivity* — Turns red in sunlight.

4.4 Chemical Properties

4.4.1 *Reactivity*

Very reactive with air or oxygen, igniting spontaneously and burning to form phosphorus pentaoxide. Reacts violently with oxidizing materials, strong caustics, ammonia, sulphur, beryllium, thorium, zirconium, various halogens, oxides, fluorides, azides, iodates, nitrides, acids, iodides, chlorides, chlorosulphonic acid, carbides, chlorates, bromates, acid anhydrides and other chemicals.

It is not hygroscopic but oxide is highly hygroscopic. To be stored under water or in nitrogen atmosphere.

4.4.2 *Polymerisation* — Not available.

4.4.3 *Allotrope Formation* — Heated to 240°C in absence of air it turns to red phosphorus.

4.4.4 *Corrosion Properties* — Phosphorus is not corrosive in absence of air or water.

4.4.4.1 Phosphorous is stored under water since it is considered insoluble in water (solubility 0.000 3 percent at 20°C); it oxidizes in the cover water and slowly acidifies it. The temperature of the cover water is a factor in the acidification. At higher temperatures, the solubility of phosphorus increases, causing a more rapid acidification. This process will, in time, corrode the container at the liquid level line. Hence, *p*H of the cover water should be periodically checked for acidity.

4.5 Fire and Explosion Hazard Properties

4.5.1 *Ignition Temperature,* 30°C.

4.5.2 *Flash Point,* not available.

4.5.3 *Fire Risk*

Very small quantities of phosphorus even after cleaning of a spill can remain covered by dust or other coating. Such material can ignite when there is movement in the place. Hence, in any area where there has been spillage of phosphorus, wearing of safety shoes should be compulsory. If any flammable material is to be taken in the same area extreme caution need to be exercised to avoid accidental fire due to spontaneous ignition.

5 HEALTH HAZARD AND TOXICITY INFORMATION

5.1 General Information

White phosphorus and its fumes (oxide) are known to have both acute and chronic health effects. They can be dermal, respiratory, eye injury and skeletal. Fatal exposure can also occur by routes such as exposure of skin, inhalation, or ingestion. Appropriate precaution in handling is essential to prevent exposure.

5.2 Routes of Entry

5.2.1 *Skin*

Phosphorus can cause severe deep burns. Systemic effects may result following absorption.

5.2.2 *Eyes*

The material can produce severe chemical burns to the eyes on direct contact. Vapours or mist are extremely irritating.

5.2.3 *Ingestion*

In an unlikely event if phosphorus is ingested it could cause severe damage to intestinal tract. It could be fatal. Death could occur in 8 to 15 days after exposure.

5.2.4 *Inhalation*

Inhalation of vapours, aerosols (mists, fumes), or dust may cause severe toxic effects. These effects could be fatal.

5.2.5 *Long Term Effects*

Phosphorus is known to cause long term effect on the skeletal system and cause condition known as phosy-jaw. Long term exposure could also cause chronic diseases of lungs or stomach.

5.3 Toxicity Information

It emits highly toxic fumes of PO_X. Available toxicity values are given below:

a) *Threshold Limit Value* — Time-weighted average [TLV (TWA)] - 0.1 mg/m^3 over each 8 h of 40 h work week.

b) *Short-Term Exposure Limit (STEL)* — 0.3 mg/m^3 for 15 min.

c) *Immediately Dangerous to Life or Health (IDLH)* — 5 mg/m$^{3.}$

d) *Lethal Dose 50 (LD50) (rat), Dermal* — 100 mg/kg.

e) *Lowest Lethal Dose (LDLo) (human) Oral* — 0.7 mg/kg.

f) *Inhalation (Rat) Lethal Concentration (LC)* — 150 mg/m^3/4 h.

5.4 Antidote

There is no antidote for white phosphorus toxicity.

5.5 Health Effects

5.5.1 *Signs and Symptoms*

Irritation of eyes and respiratory tract, abdominal pain, nausea, jaundice, anaemia, dental pain, excess saliva, jaw pain, swelling, skin burns, etc.

5.5.2 *Acute Toxicity*

5.5.2.1 *Systemic effects*

The absorption of phosphorus if swallowed may be delayed as much as 2 h. After ingestion, there is an initial stage starting in a few hours with local gastro-intestinal irritation shown by nausea, vomiting and severe abdominal pain. The vomits may have garlic like odour and may be phosphorescent (luminous in dark). After 24 to 25 h, the symptoms are remittent. In a few hours, or in 2/3 days nausea, vomiting and abdominal pain reappear with diarrhoea and tenderness. Erosion of intestinal tract and liver damage are known to occur. The skin becomes yellowish in colour. The condition progresses for 2 to 15 days, averaging 8 days. The fatal dose is generally about 50 - 100 mg, but 15 mg may be severely toxic.

5.5.2.2 *Local effects*

Phosphorus, when not surrounded by water, burns freely and will cause severe local tissue burns if it contacts the skin. The heat coagulation of the skin tissue is important effect of phosphorus burns. A firm eschar is produced and is surrounded by blisters. Phosphorus is especially hazardous to the eyes and produces severe damage.

5.5.3 *Chronic Toxicity*

5.5.3.1 *Systemic effects*

Chronic poisoning occurs from long continued absorption of phosphorus especially through the lungs but also through the gastro-intestinal tract. A form of generalized weakness, attended by anaemia, loss of appetite, gastro-intestinal complaints, chronic cough, and marked weakness and pallor has been reported to be due to systemic phosphorus poisoning. The most common form of chronic phosphorus poisoning is that of jaw necrosis. Chronic phosphorus poisoning causes changes in the long bones. Seriously affected bones may become brittle, leading to spontaneous fractures. Industrially, necrosis of the bone is seen especially in the jaw bones. In such cases, the first symptoms are usually tooth ache and excessive salivation followed by the loosening of one or more teeth and severe pain and swelling of the jaw. A suppurative ulceration develops in the gums around the tooth or the tooth socket, which advances to a deep infection of the bone itself. There is a gradual progression of the process until most of the affected bones are involved. In extreme cases severe facial deformity may result.

5.5.3.2 *Local effects*

There are no usual chronic local effects.

6 PERSONAL PROTECTIVE EQUIPMENT

6.1 Availability and Use

The personal protective equipment is not an adequate substitute for good, safe working conditions, adequate ventilation, and intelligent conduct on the part of employees working with phosphorous. In many instances, it is the only practical mean of protecting the worker, particularly in emergency situations. One should keep firmly in mind that personal protective equipment protects only the worker wearing it, and other unprotected workers in the area maybe exposed to danger.

The correct usage of personal protective equipment requires the education of the workers in proper employment of the equipment available to him. Under conditions which are sufficiently hazardous to require personal protective equipment, its use should be supervised and the type of protective equipment selected should be capable of control over any potential hazards.

6.2 Non-Respiratory Equipment

6.2.1 *Eye and Face Protection*

Chemical splash protection as per IS 8520 category H-4. Use of goggles along with full face shield is recommended. Face shield should be of sufficient length to cover the neck portion.

6.2.2 *Head Protection*

Hard hats should be worn where there is danger of falling objects. If hard hats are not considered necessary, soft-brimmed hats or caps may be worn to give protection against liquid leaks and splashes.

6.2.3 *Foot and leg Protection*

Leather safety shoes with built-in steel toecaps are recommended for workers handling drums and cans of phosphorus. Alternately rubber gumboots must be used while handling phosphorus. Leather leg guard is recommended. Shoes should be thoroughly cleaned and ventilated after contamination (*see* IS 10667).

6.2.4 *Body, Skin and Hand Protection*

Clothing made of leather, asbestos, rubber or other impervious materials may be worn to protect the body against the splashes. Leather or rubber gloves should be worn for hand protection. Fireproof overalls should be worn when operations involving phosphorus fires are encountered (*see* IS 8519 and IS 8807).

6.3 Respiratory Equipment

Respirator selection (upper limit devices).

a) *1 mg/m^3* — Dust and mist respirator with a full face-piece.

b) *2.5 mg/m^3* — Power air-purifying respirator with a high efficiency particulate filter. Supplied air respirator operated in a continuous flow mode.

c) *5 mg/m^3* — Self-contained breathing apparatus with a full face-piece. Supplied air respiratory with a full face-piece.

   Air purifying full face-piece respirator with a high efficiency particulate filter.

d) *200 mg/m^3* — Supplied air respirator with a full face-piece and operated in a pressure demand or other positive pressure mode.

e) *Emergency or planned entry in unknown concentration* — Self contained breathing apparatus with full face-piece and operated in a pressure demand or positive pressure mode.

   The above can be used in combination with an auxiliary self-contained breathing apparatus.

f) *Escape* — Air purifying full face-piece respirator with a high efficiency particulate filter. Appropriate escape type self-contained breathing apparatus.

7 STORAGE, HANDLING, LABELLING AND TRANSPORT

7.1 General

All personal handling phosphorus should use proper personal protective equipment. Appropriate fire fighting equipment should be available in the vicinity while handling phosphorus. Persons handling phosphorous should have adequate training in use of fire fighting equipment.

7.2 Storage

7.2.1 The storage containers shall be labelled or marked to identify as follows:

a) Contents of the container;

b) Name and address of the manufacturer or importer of the hazardous chemical; and

c) Physical, chemical and toxicological data as per the criteria given in the relevant schedule of the manufacture, storage and import of Hazardous Chemicals Rules, 1989. While referring to the statutes, the stipulations given in the subsequent amendments of those statutes shall be taken into account.

7.2.2 Storage of any combustible material should not be allowed in the building. Phosphorus storage tanks should be grounded to prevent danger by lightning.

7.2.3 Storage tanks may be constructed of concrete or welded steel. Bottom or side outlets are not allowed. The storage tanks should be placed in retaining basins, also to be constructed of concrete or welded steel, without bottom or side outlets. The basins should be adequate to retain the full contents of the tank or tanks with allowance for 80 - 100 mm of water coverage. Water lines should be provided to allow instant flooding of basin.

7.2.4 Sealed tanks should be equipped with frangible discs or safety valves set to release at a predetermined pressure. End of pressure relief line should open under water. An ample safety factor should be allowed to protect the tank itself. Tanks should be equipped with internal or external heating coils. Internal coils and all pipe lines should be equipped with noncorrosive section at phosphorus water interphase, to avoid corrosion at the water line. Provide ventilation where phosphorus is stored or handled inside building. Under abnormal circumstances special emergency ventilating equipment such as fans or blowers may be necessary.

7.3 Handling

7.3.1 Pipeline should be jacketed, with hot water or steam traced, to prevent freezing of the phosphorus. Line should allow for expansion and contraction, and should be sloped to the outlet to allow maximum drainage.

A warm water connection should be provided to flush out the lines after use. The line should be flushed, after every transfer with hot water and should be left free of phosphorus. Transfer lines should not be pressurised for removing blockage under any circumstances.

7.3.2 Avoid use of flexible hoses in phosphorus transfer. If hose is to be used, it should be metal braided hose of appropriate pressure rating. Upbraided hose should not be used.

7.3.3 All steel plug or gate valves are preferred. Valves should be hot water jacketed or steam traced.

7.3.4 Phosphorus is generally handled in molten form. Water displacement is the safest method of transfer. Phosphorus should always be submerged under water. The usual handling temperature is 55°C. Below that, it is excessively viscous. Above 65°C it tends to float, it may reach the water surface and catch small fires or generate fumes.

7.3.5 Transport tankers are filled with hot water. During transfer molten phosphorus displaces the water, which is returned to the tank from which the phosphorus is displaced or pumped.

7.3.6 One storage tank equal in capacity to the largest tank in use should be kept free at all times to transfer phosphorus in case of emergency.

7.4 Labelling

7.4.1 Each container (including tank cars) should carry an identifying label or stencil. Manufacturers name with any label warnings required by regulations or ordinances form part of the label or placard.

7.4.2 Each drum must be labelled “FLAMMABLE SOLID”.

7.4.3 Each tanker and each railroad car carrying one or more containers of phosphorus must bear the “DANGEROUS” placard in addition.

7.5 Transport

Containers generally used for transport of phosphorous are:

a) Tankers - which are insulated and without bottom outlet;

b) Metal barrels or drums; and

c) Metal boxes or containers with inside containers being hermetically sealed metal cans enclosed in other hermetically sealed metal cans or box liners.

In all cases phosphorus is to be stored under a layer of water or under inert gas.

7.5.1 *Unloading Trucks*

Unloading stations should be equipped with safety showers. The truck should be spotted accurately and levelled. Stoppers/pegs should be used to avoid movement of truck during unloading. Supplier’s instructions for unloading should always be followed and all caution markings on both sides of trucks should be read and observed. Truck unloading should be preferably to tank at same level or at lower level. Truck should not be unloaded to a tank at higher elevation.

7.5.2 *Unloading Drums*

Ensure that all fittings are tight. Loosen plug in bung opening. Heat material by dipping drum in hot water in a tub or open tank to proper temperature, that is, above 44°C and below 55°C. Heat preferably to about 52°C, prior to applying water to displace the material.

7.5.3 *Driver*

Only driver trained in phosphorus handling should be employed for transportation of phosphorus. Driver should carry TREM card when vehicle is on road.

NOTE — If transport of the hazardous chemical is involved it shall be carried out in accordance with the Central Motor Vehicles Rules, 1989. While referring to the statutes, the stipulations given in the subsequent amendments of those statutes shall be taken into account.

8 SPILLAGE, LEAKAGE AND WASTE DISPOSAL

8.1 General

All personnel attending to spill/leak should use proper personal protective equipment and fire fighting equipment while handling phosphorus.

8.2 Spillage

8.2.1 *Genera/Information*

Proceed with caution. Restrict access to area. Keep unprotected personnel away and upwind of spill area. Avoid contact with spilled product. Protect sewers and waterways from contaminated runoff. Notify proper authorities. Plan response such that all physical contact with phosphorus should be avoided and that the product may ignite spontaneously in air when dry. Water in containers should be maintained between *p*H 5.5 and 6.5 to prevent evolution of hydrogen from action of phosphoric acid on metal, and from evolution of toxic and flammable phosphine gas.

8.2.2 *Land Spill (Spill on Land)*

8.2.2.1 *Containment*

Phosphorus may be contained by building dikes or barrier using sand, and or similar materials, and then covered with water, wet sand or dirt. Remove contained product as soon as possible to prevent spread of contamination. Keep product wet before and after removal.

8.2.2.2 *Consequence*

Any phosphorus that escapes may ignite upon drying.

8.2.2.3 *Mitigation*

Area cleared of spilled phosphorus may remain contaminated. There can be spontaneous fire. After removing spilled phosphorus the residual contamination should be allowed to burn off under supervision to ensure complete decontamination.

8.2.3 *Water Spill (Spill in Water)*

8.2.3.1 *Containment*

Stop use of water. Notify proper authorities to stop water intake or to monitor water for contamination. Spilled product will sink in water. Use natural deep water pockets, excavated lagoons, or sand bag barriers to trap material on bottom and limit spread of contamination.

8.2.3.2 *Mitigation*

Collect solid phosphorus from under water using PPEs. Collect into a drum previously partly filled with water to prevent air exposure of phosphorus. Drum can be heated as shown under drum handling in **7.5.2** to melt and transfer phosphorus to a storage tank.

8.3 Leakages

8.3.1 *General Information*

Leakages whether large or small, a leak from a drum or tank containing phosphorus is most effectively controlled at the source by applying a small stream of cold water to the wall of the vessel. The water chills the liquid phosphorus and converts it to the solid form. Keep the plug formed, wet to prevent re-ignition and melting till other means of containment are arranged. Phosphorus in the solid form, when not covered with water, will ignite and burn slowly at first.

In case there is leak in a tank pipeline or storage vessel molten phosphorus will flow in a stream and form a pool of liquid on the ground. The liquid now can be restricted with earth and then covered with a layer of water which will effectively smother the burning phosphorus. In the absence of water, burning phosphorus can be smothered by using sand.

8.3.2 *Leak from the Truck*

If possible apply a stream of cold water on the leak point to freeze the phosphorus or adjust, to bring the leak on top side or try to dip the drums in water. Application of water should be gentle to avoid splashing of liquid phosphorus due to force of water.

8.3.3 *Caution*

High pressure water or stream of great velocity should not be used against phosphorus. Such high velocity streams have the effect of atomizing or scattering molten phosphorus into many small particles, such of which will burn violently in separate fires.

8.4 Waste Disposal

8.4.1 Disposal of phosphorus as such is generally not permissible. Contaminated material (such as a soil phosphorus mixture left after extinguishing of splash fire) should be taken to an isolated area and burned.

8.4.2 Water in contact with phosphorus (Phossy Water) should be chemically treated before allowing it to flow out of the plant.

8.4.3 Returnable drums should be thoroughly washed inside and outside with warm water, drained and cover tightly before returning. Non-returnable containers before scrapping, should be thoroughly washed with warm water until all traces of phosphorus have been removed.

9 FIRE PREVENTION AND FIRE FIGHTING

9.1 General

Phosphorus is not explosive. Phosphorus ignites spontaneously upon contact with air or oxygen and burns vigorously forming P_2O_5, a great cloud of white smoke which is a strong irritant, corrosive to the skin, eyes and the mucous membrane.

All personal engaged in fire fighting operation must use appropriate PPEs to prevent exposure.

9.2 Prevention

9.2.1 Fires are controlled by exclusion of air, using water, sand or carbon dioxide extinguishers. High pressure water should not be used, as it would scatter the material, causing secondary fires.

9.2.2 Move container from fire area if without risk. Use water from side and from safe distance to keep fire exposed containers cool.

9.3 Fire Fighting

Phosphorus fires can be controlled with water. Containment of liquid phosphorus is crucial.

10 TRAINING

10.1 Safety in handling phosphorus depends upon the effectiveness of employee education, training and supervision. The education and training of employees to work safely and to use the personal protective equipment and other safe guards provided for them is a responsibility of supervision. Employee education and training should emphasize the need of handling phosphorus according to the methods outlined in the manual, in order to avoid spilling or splashing, leaks, burns, inhalation of the vapour of burning material, or ingestion.

Unauthorised and untrained employees should not be permitted in areas where phosphorus is being handled.

10.2 Before being placed on the job, all new employees should be instructed thoroughly for the proper handling of phosphorus. Older employees should be re-instructed periodically.

10.3 Each employee should know the location, purpose and maintenance of personal protective equipment (PPEs) and be thoroughly trained when and how to use it. Each employee should know the location of safety showers, fountains for flushing the eyes, and hose lines.

10.4 Only reliable, dependable and properly trained employees should be given the responsibility of all operations involving storage, handling, transport and emergency management involving phosphorus.

10.5 Employee should be trained to report to the proper authority about all suspected leaks or equipment failure.

10.6 They should be instructed to inform to supervisors any signs of illness or skin related problems.

10.7 Each employee should know what to do in emergency and the first-aid measures and should realize the necessity for the prompt application of first-aid in case of contact with phosphorus or exposure to the vapours of the burning material.

11 HEALTH MANAGEMENT, FIRST-AID AND MEDICAL TREATMENT

11.1 Health Monitoring

11.1.1 *Personal Hygiene*

11.1.1.1 Employees should bath daily after finishing work. They should report any abnormal condition of the mouth or skin to medical department.

11.1.1.2 Food should not be stored or eaten near the place where phosphorus is being handled.

11.1.2 *Physical Examination*

11.1.2.1 *Pre-placement physical examinations*

Pre-placement medical examination should be directed toward eliminating from exposure to phosphorus those workers with any evidence of history of liver disease and those workers with any of the following dental defects: gingivitis, pyorrhoea, carious teeth, exposed sockets and dental cysts. Absence of all natural teeth is no contraindication.

Employees who have or had syphilis should not be exposed to phosphorus.

11.1.2.2 *Periodic examination*

The extent of medical or dental control depends upon the amount of exposure to phosphorus. Where there is a prolonged exposure to open phosphorus, the following procedures are recommended.

11.1.2.3 *Medical examination*

An annual physical examination should be conducted for each employee who is constantly exposed to phosphorus. He should be instructed to report any illness, or any disorder of skin that he experiences.

Liver function test and complete blood count on annual basis is recommended.

11.1.2.4 *Dental examination* — Periodical dental examinations may be conducted.

11.2 First Aid

11.2.1 *General Principles*

First-aid treatment should be started at once in all cases of contact with phosphorus in any form otherwise serious injury may result. Refer all injured persons to a physician even when the injury appears to be slight. Give the physician a detailed account of the accident. First aider is also at risk of exposure to phosphorus and should wear proper PPEs.

11.2.2 *Contact with Skin*

Immediate application of water to the area stops combustion of phosphorus. This may be accomplished by plunging the affected parts in water or by the copious use of running water. Phosphorus ignites when exposed to air or when it dries on clothing or skin. Therefore, get victim, or burned areas, under water as quickly as possible using a water bucket, a hose, a shower, a tank or a tub if necessary. Remove clothing under water. Any skin areas which may have phosphorus on them MUST BE KEPT IMMERSED IN WATER to exclude air until phosphorus can be removed.

It should be borne in mind that in severe burns and those involving a large area of body surface, shock may appear at any time. This should be treated promptly by laying the patient down and keeping him reasonably warm until the physician arrives. No oil or ointment of any kind should be applied to burnt areas.

11.2.2.1 *Caution*

It should be remembered that the phosphorus stops burning after the application of water but when the area dries, due to the evaporation of water, the phosphorus will spontaneously ignite again. Drying may be prevented by covering the area with a cloth wet with water of 0.5 percent silver nitrate solution. The phosphorus must be removed as soon as possible. A physician should be called at the earliest possible moment, till then continue silver nitrate solution treatment.

11.2.3 *Contact with Eyes*

lf even minute quantities of phosphorus either in solid form or in solution, enter the eyes they should be thoroughly washed immediately and copiously with water for a minimum of 15 min. The eyelids should be held apart during the eye washing to ensure contact of water with entire tissue of the surface of the eyes and lids. A physician, preferably an eye specialist, should be called in attendance at the first possible instance. If a physician is not immediately available, the eye washing should be continued for a second period of 15 min. After the first 15 min period of eye washing is completed, it is permissible, as a first-aid measure, to instil two or three drops of an 0.5 percent aqueous topical anaesthetic. No oils or oily ointments should be instilled unless ordered by the physician.

11.2.4 *Ingestion*

If phosphorus is swallowed, either in a paste or as ‘phossy water’, a physician should be called immediately. There is no established antidote. Gastric lavage should be performed at the earliest. If lavage can not be performed the patient should be made to vomit at once by giving large quantities of water or salt solution (1 table spoonful of salt to 1 quarter of water). If necessary, stick finger down the throat to cause vomiting. Gastric lavage may be performed many hours after ingestion using copious quantities of potassium permanganate. Repeated vomiting should be encouraged by giving large quantities of fluids. Liquid paraffin (100 - 200 ml) should be introduced into the stomach following lavage and left there. Avoid digestible fats and oils. Physician should be called at once. Care to be taken to protect patient and attendant from vomitus which may contain phosphorus.

11.2.5 *Inhalation*

11.2.5.1 Inhalation of phosphorus vapour itself has not cause acute symptoms but the person should be immediately removed to fresh air.

When phosphorus is burning, concentrations of the oxides of phosphorus are formed which are principally phosphorus pentaoxide. The products of oxidation are a lung irritant. The patient should be removed to fresh air at once. If the patient has respiratory distress or a persistent cough, medical oxygen is indicated. A physician should be called at once.

11.2.5.2 Burning phosphorus in a confined area may cause a depletion of the oxygen from the air to a sufficient extent to cause asphyxiation. The patient should be removed at once to fresh air and effective artificial respiration initiated immediately if breathing has ceased. A physician should be called at once.

11.2.6 *First-Aid Kit*

First-aid kit containing the following item should be kept handy:

a) 0.5 percent silver nitrate solution;
b) Sofratulle sterilized gauzes; and
c) Silversulpha ointment. (if patient is not allergic to Sulpha drugs).

11.3 Medical Treatment

11.3.1 Liquid paraffin (100 - 200 ml) should be introduced into the stomach following lavage and left there. Do not give digestible fats and oils.

11.3.2 Isotonic solutions of sodium chloride and sodium lactate, parenterally combat shock, dehydration and acidosis. Glucose infusion may be required to correct hypoglycemia. Calcium gluconate may be required if hypocalcaemia appears.

11.3.3 Morphine and other opiates to control pain.

11.3.4 Vitamin K1 in large doses (for example, 65 mg slowly by intravenous drip) may combat hypothrombinaemia but transfusions of fresh whole blood may be necessary to correct coagulation defect and anemia.

11.3.5 Supportive treatment for delirium and convulsions.

11.3.6 General supportive measures for hepatic insufficiency and more rarely renal failure.

11.3.7 Treat skin burns by washing with warm water or with 1 percent silver nitrate. As long as un-oxidised phosphorus remains embedded in the skin, the contaminated area should be submerged in water or silver nitrate solution. Visible pieces can be surgically removed.

12 ADDITIONAL INFORMATION

Additional information essential for particular equipment used for handling of phosphorous, Security measures to be taken while handling of phosphorous etc as essential for controlling hazards may be collected and applied.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Chemical Hazards Sectional Committee, CHD 07

Organization	*Representative(s)*
In Personal Capacity (*Flat 1204, Bhumika Residency Co Housing Society, Sector 20, Plot 21 Roadpali Kalamboli, 410218*)	Shri K. S. Ramprasad (***Chairman***)
Alkali Manufacturers Association of India, Mumbai	Shri K. Srinivasan Shri H. S. Das (*Alternate*)
Bhabha Atomic Research Centre, Mumbai	Ms Garima Singh Shri Nishith Gosh (*Alternate*)
Central Food Technological Research Institute, Mysore	Dr Dandamudi Usharani Dr Prasanna Vasu (*Alternate*)
Central Leather Research Institute, Chennai	Dr M. Suriyanarayanan
Centre for Fire, Explosives and Environmental Science, Ministry of Defense Government of India	Shri S. P. Dobhal Dr Aarti Bhatt (*Alternate*)
Crop Care Federation of India, New Delhi	Mr P. N. Karlekar Dr J. C. Majumdar (*Alternate*)
Defence Research and Establishment, (DRDO), Gwalior	Dr Prabhat Garg Dr Virendra Vikram Singh (*Alternate*)
Department of Chemicals and Petrochemicals, Ministry of Chemicals and Fertilizers, Government of India	Dr Vishal Choudhary
Department of Space(ISRO), Bengaluru	Shri Muraleekrishnan R. Ms Lakshmi V. W. (*Alternate*)
Directorate General Factory Advice Service and Labour Institutes, Mumbai	Shri H. M. Bhandari Shri P. G. Satpute (*Alternate*)
Gas Industries Association	Shri Sunil Kher Shri Anoop Tandon (*Alternate*)
Hindustan Unilever Ltd, Mumbai	Shri Sanjay Harlaka Shri Rakesh Wadalkar (*Alternate*)
Indian Chemical Council, Mumbai	Dr C. Nandi Dr Rakesh Kumar (*Alternate*)
Indian Institute of Chemical Technology, Hyderabad	Dr Bankupalli Satyavathi Dr Sripadi Prabhakar (*Alternate*)
Indian Institute of Petroleum, Dehradun	Dr Neeraj Atray Dr Pankaj Kumar Kanujia (*Alternate*)
Indian Institute of Technology, Chennai	Dr Sachin Gunte
Indian Institute of Technology, Mumbai	Prof Sandip Roy
Indian Institute of Toxicology Research, Lucknow	Dr D. K. Patel Dr Sheelendra Pratap Singh (*Alternate*)
Indira Gandhi Centre for Atomic Research, Kalpakkam	Dr K. K. Satpathy
Institute of Chemical Technology, Mumbai	Prof Dr G. D. Yadav Dr B. M. Bhanage (*Alternate*)

Organization	*Representative(s)*
Ministry of Environment and Forest, New Delhi	Shri Ved Prakash Mishra Dr Dinesh Runiwal (*Alternate*)
National Chemical Laboratory, Pune	Dr Vijay V. Bokade Dr M. Muthukrishnan (*Alternate*)
National Institute of Occupational Health, Ahmedabad	Dr B. Ravichandran
National Institute of Technology, Thrichi	Prof S. P. Sivapirakasam Dr Sreejith Mohan (*Alternate*)
National Safety Council, Navi Mumbai	Shri A. Y. Sundkar Shri K. D. Patil (*Alternate*)
Oil Industry Safety Directorate (Ministry of Petroleum and Natural Gas), Delhi	Shri Devendar M. Mahajan
Pesticides Manufacturer and Formulators Association of India	Dr Archana Kumari Dr Sandip Singh (*Alternate*)
Petroleum and Explosives Safety Organisation, Nagpur	Shri M. K. Jhala Dr Yogesh Khare (*Alternate*)
Safety Appliances Manufacturers Association , Mumbai	Shri Mohammad Shri Devang Mehta (*Alternate*)
Shriram Institute for Industrial Research, Delhi	Dr Jagdish Kumar Dr Deep Shankar Chatterjee (*Alternate*)
Tata Chemicals Ltd, Mithapur, Distt, Jamnagar	Shri Snehashish A. Chakraborty Shri D. K. Thakur (*Alternate*)
In personal capacity (*I-4/2/6, Parijat C.H.S., Spaghetti, Sector-15, Kharghar, Navi Mumbai, 410210*)	Shri S. Soundararajan
BIS Directorate General	Shri Ajay K. Lal, Scientist 'E' and Head (CHD) [Representing Director General (*Ex-officio*)]

Member Secretary

Ms Shubhanjali Umrao
Scientist 'B' (CHD), BIS

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Head (Publication & Sales), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

This Indian Standard has been developed from Doc No.: CHD 07 (17333).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices: *Telephones*

Central : 601/A, Konnectus Tower-1, 6th Floor, DMRC Building, Bhavbhuti Marg, New Delhi 110002 — 2323 7617

Eastern : 8th Floor, Plot No 7/7 & 7/8, CP Block, Sector V, Salt Lake, Kolkata, West Bengal 700091 — 2367 0012, 2320 9474

Northern : Plot No. 4-A, Sector 27-B, Madhya Marg Chandigarh 160019 — 265 9930

Southern : C.I.T. Campus, IV Cross Road, Taramani, Chennai 600113 — 2254 1442, 2254 1216

Western : Plot No. E-9, Road No.-8, MIDC, Andheri (East), Mumbai 400093 — 2821 8093

Branches : AHMEDABAD. BENGALURU. BHOPAL. BHUBANESHWAR. CHANDIGARH. CHENNAI. COIMBATORE. DEHRADUN. DELHI. FARIDABAD. GHAZIABAD. GUWAHATI. HIMACHAL PRADESH. HUBLI. HYDERABAD. JAIPUR. JAMMU & KASHMIR. JAMSHEDPUR. KOCHI. KOLKATA. LUCKNOW. MADURAI. MUMBAI. NAGPUR. NOIDA. PANIPAT. PATNA. PUNE. RAIPUR. RAJKOT. SURAT. VISAKHAPATNAM.

Published by BIS, New Delhi